

What Is Claimed Is:

1 1. A method for computing interval parameter bounds from fallible
2 measurements, comprising:
3 receiving a set of measurements z_1, \dots, z_n , wherein an observation model
4 describes each z_i as a function of a p -element vector parameter $\mathbf{x} = (x_1, \dots, x_p)$;
5 storing the set of measurements z_1, \dots, z_n in a memory in a computer
6 system;
7 forming a system of nonlinear equations $z_i - h(\mathbf{x}) = 0$ ($i=1, \dots, n$) based on
8 the observation model; and
9 solving the system of nonlinear equations to determine interval parameter
10 bounds on \mathbf{x} .

1 2. The method of claim 1, wherein the system of nonlinear equations
2 is an "overdetermined system" in which there are more equations than unknowns.

1 3. The method of claim 1, wherein each measurement z_i is actually a
2 q -element vector of measurements $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$, and h is actually a q -element
3 vector of functions $\mathbf{h} = (h_1, \dots, h_q)^T$.

1 4. The method of claim 1,
2 wherein receiving the set of measurements involves receiving values for a
3 set of conditions c_1, \dots, c_n under which the corresponding observations z_i were
4 made; and
5 wherein equations in the system of nonlinear equations account for the
6 conditions c_i and are of the form $z_i - h(\mathbf{x} | c_i) = 0$ ($i=1, \dots, n$).

1 5. The method of claim 4, wherein each condition c_i is actually an r -
2 element vector of conditions $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$.

1 6. The method of claim 4, wherein each condition c_i is not known
2 precisely but is contained within an interval c_i^l .

1 7. The method of claim 4, wherein equations in the system of
2 nonlinear equations are of the form $z_i - h(\mathbf{x} | c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$ ($i=1, \dots, n$), which
3 includes an error model $\varepsilon^l(\mathbf{x}, c_i)$ that provides interval bounds on measurement
4 errors for z_i .

1 8. The method of claim 7, wherein if z_i is actually a q -element vector
2 of measurements $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$, then ε^l is actually a q -element vector
3 $\boldsymbol{\varepsilon}^l = (\varepsilon_1, \dots, \varepsilon_q)^T$.

1 9. The method of claim 7, wherein if there exists no solution to the
2 system of nonlinear equations, the method further comprises determining that at
3 least one of the following is true:
4 at least one of the set of measurements z_1, \dots, z_n is faulty;
5 the observation model $h(\mathbf{x} | c_i)$ is false;
6 the error model $\varepsilon^l(\mathbf{x}, c_i)$ is false; and
7 the computational system used to compute interval bounds on elements of
8 \mathbf{x} is flawed.

1 10. The method of claim 1, wherein solving the system of nonlinear
2 equations involves:

3 linearizing the system of nonlinear equations to form a corresponding
4 system of linear equations; and
5 solving the system of linear equations.

1 11. The method of claim 10, wherein solving the system of nonlinear
2 equations involves using Gaussian Elimination.

1 12. A computer-readable storage medium storing instructions that
2 when executed by a computer cause the computer to perform a method for
3 computing interval parameter bounds from fallible measurements, the method
4 comprising:

5 receiving a set of measurements z_1, \dots, z_n , wherein an observation model
6 describes each z_i as a function of a p -element vector parameter $\mathbf{x} = (x_1, \dots, x_p)$;

7 storing the set of measurements z_1, \dots, z_n in a memory in a computer
8 system;

9 forming a system of nonlinear equations $z_i - h(\mathbf{x}) = 0$ ($i=1, \dots, n$) based on
10 the observation model; and

11 solving the system of nonlinear equations to determine interval parameter
12 bounds on \mathbf{x} .

1 13. The computer-readable storage medium of claim 12, wherein the
2 system of nonlinear equations is an "overdetermined system" in which there are
3 more equations than unknowns.

1 14. The computer-readable storage medium of claim 12, wherein each
2 measurement z_i is actually a q -element vector of measurements $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$,
3 and h is actually a q -element vector of functions $\mathbf{h} = (h_1, \dots, h_q)^T$.

1 15. The computer-readable storage medium of claim 12,
2 wherein receiving the set of measurements involves receiving values for a
3 set of conditions c_1, \dots, c_n under which the corresponding observations z_i were
4 made; and
5 wherein equations in the system of nonlinear equations account for the
6 conditions c_i and are of the form $z_i - h(\mathbf{x} \mid c_i) = 0$ ($i=1, \dots, n$).

1 16. The computer-readable storage medium of claim 15, wherein each
2 condition c_i is actually an r -element vector of conditions $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$.

1 17. The computer-readable storage medium of claim 15, wherein each
2 condition c_i is not known precisely but is contained within an interval c_i^l .

1 18. The computer-readable storage medium of claim 15, wherein
2 equations in the system of nonlinear equations are of the form,
3 $z_i - h(\mathbf{x} \mid c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$ ($i=1, \dots, n$), which includes an error model $\varepsilon^l(\mathbf{x}, c_i)$ that
4 provides interval bounds on measurement errors for z_i .

1 19. The computer-readable storage medium of claim 18, wherein if z_i
2 is actually a q -element vector of measurements $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$, then ε^l is
3 actually a q -element vector $\boldsymbol{\varepsilon}^l = (\varepsilon_1, \dots, \varepsilon_q)^T$.

1 20. The computer-readable storage medium of claim 18, wherein if
2 there exists no solution to the system of nonlinear equations, the method further
3 comprises determining that at least one of the following is true:
4 at least one of the set of measurements z_i, \dots, z_n is faulty;

5 the observation model $h(\mathbf{x} \mid c_i)$ is false;
6 the error model $\varepsilon^l(\mathbf{x}, c_i)$ is false; and
7 the computational system used to compute interval bounds on elements of
8 \mathbf{x} is flawed.

1 21. The computer-readable storage medium of claim 12, wherein
2 solving the system of nonlinear equations involves:
3 linearizing the system of nonlinear equations to form a corresponding
4 system of linear equations; and
5 solving the system of linear equations.

1 22. The computer-readable storage medium of claim 21, wherein
2 solving the system of nonlinear equations involves using Gaussian Elimination.

1 23. An apparatus that computes interval parameter bounds from
2 fallible measurements, comprising:
3 a receiving mechanism configured to receive a set of measurements
4 z_1, \dots, z_n , wherein an observation model describes each z_i as a function of a
5 p -element vector parameter $\mathbf{x} = (x_1, \dots, x_p)$;
6 a memory in a computer system for storing the set of measurements
7 z_1, \dots, z_n ;
8 an equation forming mechanism configured to form a system of nonlinear
9 equations $z_i - h(\mathbf{x}) = 0$ ($i=1, \dots, n$) based on the observation model; and
10 a solver configured to solve the system of nonlinear equations to determine
11 interval parameter bounds on \mathbf{x} .

- 1 24. The apparatus of claim 23, wherein the system of nonlinear
2 equations is an “overdetermined system” in which there are more equations than
3 unknowns.
- 1 25. The apparatus of claim 23, wherein each measurement z_i is actually
2 a q -element vector of measurements $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$, and h is actually a q -
3 element vector of functions $\mathbf{h} = (h_1, \dots, h_q)^T$.
- 1 26. The apparatus of claim 23,
2 wherein the receiving mechanism is additionally configured to receive
3 values for a set of conditions c_1, \dots, c_n under which the corresponding
4 observations z_i were made; and
5 wherein equations in the system of nonlinear equations account for the
6 conditions c_i and are of the form $z_i - h(\mathbf{x} | c_i) = 0$ ($i=1, \dots, n$).
- 1 27. The apparatus of claim 26, wherein each condition c_i is actually an
2 r -element vector of conditions $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$.
- 1 28. The apparatus of claim 26, wherein each condition c_i is not known
2 precisely but is contained within an interval c_i^l .
- 1 29. The apparatus of claim 26, wherein equations in the system of
2 nonlinear equations are of the form $z_i - h(\mathbf{x} | c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$ ($i=1, \dots, n$), which
3 includes an error model $\varepsilon^l(\mathbf{x}, c_i)$ that provides interval bounds on measurement
4 errors for z_i .

1 30. The apparatus of claim 29, wherein if z_i is actually a q -element
2 vector of measurements $z_i = (z_{i1}, \dots, z_{iq})^T$, then ε^I is actually a q -element vector
3 $\varepsilon^I = (\varepsilon_1, \dots, \varepsilon_q)^T$.

1 31. The apparatus of claim 29, wherein if there exists no solution to the
2 system of nonlinear equations, the solver is configured to determine that at least
3 one of the following is true:
4 at least one of the set of measurements z_i, \dots, z_n is faulty;
5 the observation model $h(\mathbf{x} \mid c_i)$ is false;
6 the error model $\varepsilon^I(\mathbf{x}, c_i)$ is false; and
7 the computational system used to compute interval bounds on elements of
8 \mathbf{x} is flawed.

1 32. The apparatus of claim 23, wherein the solver is configured to:
2 linearize the system of nonlinear equations to form a corresponding system
3 of linear equations; and to
4 solve the system of linear equations.

1 33. The apparatus of claim 32, wherein the solver is configured to
2 solve the system of nonlinear equations using Gaussian Elimination.